

FEYNMAN DIAGRAMS

Feynman diagrams are schematics depicting particle interactions on the subatomic level or their decay. Each diagram has an associated mathematical expression. One simple example is electron (e^-) and positron (e^+) annihilation creating photon (γ) which in turn creates new electron and positron.

$$e^- + e^+ \rightarrow \gamma \rightarrow e^- + e^+$$

Symbols used are: solid straight line for the fermions (quark, electron, muon, neutrino, tauon), wavy line for photon, W or Z boson, curly line is for gluon, dashed line is for Higgs boson and dots (vertices) stand for the place of interaction.

Called Feynman–Stückelberg interpretation, an interesting characteristic of the FDs is that an antiparticle is presented as moving back in time due to the fact that both particle and antiparticle have equal mass and spin but opposite charge.

For his work in quantum electrodynamics Richard Phillips Feynman, American theoretical physicist, shared Nobel prize in physics 1965. with Sin-Itiro Tomonaga and Julian Schwinger.

Frank Wilczek emphasized importance of FDs when receiving his Nobel prize in physics 2004. for the discovery of asymptotic freedom in strong interaction. An atomic core is connected with a bond that holds not only protons and neutrons in the core but also quarks in protons and neutrons. But when quarks from different sources come very close to one another they behave rather freely.

One of practical applications of the Feynman diagrams is their use with the harmonic oscillators, like pendulum, spring or atom, in a perturbative quantum mechanics for a purpose of probability calculations.

FIELD THEORY

Field theory is an idea that underneath reality as we know it, comprised of matter and energy, lies a field(s) from which the same reality arise.

First such classical theory emerged from Newton's study of gravity, explained as "action at a distance", but it wasn't Newton who established the concept itself. It was developed some time later in 18th century, based on his teachings, when scientists described gravity in the form of vectors appointing each position in space with specific value.

Michael Faraday invented the term "field" in 1845. proposing that it exists and produces physical effects even in an absence of matter with Maxwell equations completing the set in 1864. relating an electric and magnetic field, electric power and charge. Furthermore, Maxwell equations indicated occurrence of an electromagnetic waves traveling at the speed of light. Notion of "action at a distance" was abandoned. Classical view short-lived replaced with much more subtle, quantum concept developed through Max Planck's black body radiation research. Planck found that atoms are harmonically oscillating, absorbing and emitting EM flux in a form of discrete energy amounts called "quanta".

In 1927. Paul Dirac forged a term quantum electrodynamics (QED) introducing an additional interaction amid electricity and EM potential. Appearing to emit spontaneously, quantum harmonic oscillators do not behave still but are always vibrating having a non-zero lowest energy at a ground state. Hence, even in a space vacuum there is a vibrating EM field producing quantum fluctuations that prompt electrons to radiate energy. This phenomenon is referred to as quantum field thus definitely leaving behind classical, Newtonian approach.

INFLATION THEORY

Inflation theory is an idea that Universe in early stage of development, some 10⁻³⁶ to 10⁻³² second, underwent superfast, faster than light, phase of formation. It always reminds me of loading a program into computer. Perhaps in Cosmic case someone loaded the field(s) with capsule of instructions. Maybe sort of universal DNA was conveyed into a Space chipset. What is the mainframe? Or matter leaked through a black hole singularity on other side initially exponentially inflating, in a bubble like manner, until bursting and expanding further although at somewhat slower tempo yet still much faster than light.

Inventor of this approach is Alan Guth but other notable scientists significantly contributed like Alexei Starobinsky and Andrei Linde. It explains many problems like quantum fluctuations transition to the macroscopic scale, why is Universe isotropic and homogeneous as well as why the cosmic microwave background radiation is identically distributed, why temperatures and curvatures in far regions are almost equal (without inflation velocity laws of thermodynamics would be violated, curv. = 0), flatness, horizon (communication) and lack of magnetic monopoles. Answer is in the cosmological constant which has been sizeable in the beginning while later dropping to a zero value. Actually we get proportional ratio between it and Universe dimensions. Hence, it is not constant at all but variant.

Alan Guth proposes that during inflation period Cosmos was extremely

cooled and radiated through an alternative process known as "quantum tunneling". Process itself was driven by scalar, inflaton field.

Paul Steinhardt and Andreas Albrecht, also recognized as pioneers of inflation, propose "slow-roll" model revealing the role of Hubble friction in sustaining an inflation until reaching critical plateau.

STRING THEORY

There are two widely accepted frameworks existing in modern physics. Quantum theory which describes the Universe on the subatomic level and general relativity which explains it on the macroscale. Problem is that neither define gravity.

Science has different solution called String theory which interprets the fundamental building blocks of reality not like particles but like tiny, vibrating strings yielding into rudimentary segments by means of oscillation.

For some time now, I have considered a possibility that waves are a channel of communication between three layers of reality: fields, energy and matter and that exactly through oscillations reality comes into being.

Peculiar circumstance arises out from string mathematics: a necessity for extra dimensions twined and pressed together making them unobservable. This can be done in myriad ways. Are we talking about Multiverse? Yes, with every single spacetime continuum divergent from others.

There are some variants of string theory, like superstring theory and M-theory, but basically all strings have common characteristic of being tensely open or closed thus producing entire wave spectrum. One of their modes could be graviton, hypothetical particle responsible for making gravitational effect.

QUANTUM GRAVITY

Since matter is created Ex Nihilo, I think gravity is tendency to restore previous state of nothingness, in an elastic manner, meaning annihilation of substance and its counterpart. Issue is solved by dumping anti-matter into a black holes, reservoirs where it sinks under the field(s) or emerges on the other side, or/and with diversification, shuffling and re-combination of

subatomic particles resulting in a stable surroundings. Until opposites meet and mutually cancel with big blast releasing huge amount of energy. If we track the same principle backwards then natural order of things becomes obvious: fields produce energy which transforms into dual substance. Reversed: matter and anti-matter transform into energy which returns to the fields. Quantum fluctuations are proofs of "fields to energy to fields" cycle.

An idea of Quantum Gravity incorporates general relativity (laws of macrocosmos), with predicted singularity in the core of a black hole, and quantum mechanics (Planck scale interactions), valid on a subatomic level.

LOOP QUANTUM GRAVITY

As one of subordinates, Loop Quantum Gravity describes the structure of a spacetime continuum like network consisting of countable arcs (loops) integrated into more complex systems called spin matrices.

Gravity is only force which has not yet been scientifically explained using standard physical terms. For contrast, electromagnetism, strong and weak force are very well defined. Just take an electric circuit, look how nucleus breaking sets free an enormous energy or observe particles decay.

Main problem with the QG is that process unfolds at or near the Planck scale which is currently unreachable by an existing technical means.

Using common sense and principles of equivalence, scientists think that there must be a messenger particle responsible for gravity. Hypothetical in nature, this particle is named "graviton".

Recently, Quantum theory merged with String theory resulting with an idea of connecting holography as an intermediate cross section between different zones of spacetime and underlying fields, explaining quantum entanglement and error correction.

Hong Liu and Krishna Rajagopal are pioneers of holography usage in order to find deeper insights into the quark-gluon plasma affairs.

Hong Liu is also among the first ones pointing at plausible correspondences between (cooled) black holes and (heated) superconductors. His work

includes superstates of matter, (apparent) quantum disorder and fluctodynamics formulation.

Rana Adhikari thinks that Universe is constructed from little, pixel-like segments which are prophecies of the quantum gravity. In other words, spacetime is quantized. She, Zurek and colleagues plan to prove the theory by detecting observable signatures with simple, low-energy desktop instruments experiment named "Gravity from Quantum Entanglement of Space-Time (GQuEST abbr.)" working at accessible 10-18 scale.

In the case of LIGO, gravitational waves extort influence on sensors while in the much more modest GQuEST case interferometers will search for laser induced gravitational effect producing fluctuations in the form of gravitons or, so called, "quantum foam". Instead on particular emergences, scientists will focus their attention at longer links in-between occurrences. Strength of this minuscule events is enough to disturb a light beam (stream of photons) observable with a single-photon detector.

Distinct approach to QG is "causal dynamical triangulation" which says that on infinitesimal level surface of the spacetime fabric becomes two dimensional (flat).

19/02/2024